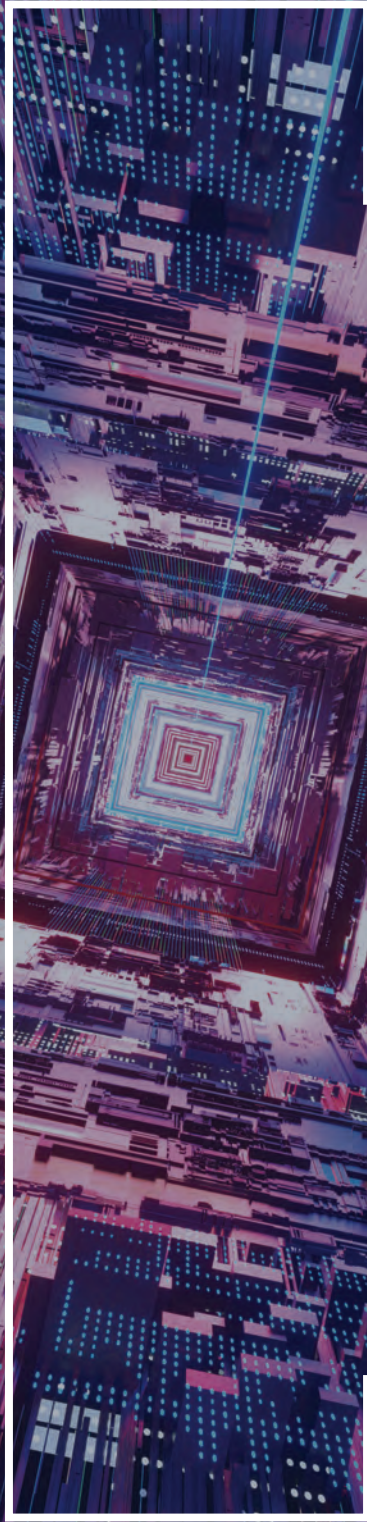


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Foreword

Technology was once the domain of computer engineers and programmers. It was for these experts to understand, while the rest of the world simply enjoyed the benefits or suffered through the glitches. Now concepts that once belonged to science fiction, such as artificial intelligence (AI), have not only become a dominant feature of our everyday lives but also are evolving so rapidly that it often feels impossible to keep up.

It is the burden of policymakers — whether they be ministers, civil servants, or Members of Parliament sitting on a select committee — to understand how technology that we all take for granted works. They need to know how and why consumers benefit as well as the wider implications for the public sector, economy, labour market, and public well-being. On top of this, they must also understand what is on the horizon and how government or Parliament may be required to step in and regulate.

Our intention for Government Tech Insider is for it to serve as a bridge between policymakers and digital technologies that are changing the world. In this document, we highlight a number of concepts, explain what they do and how they work, and signpost why lawmakers need to understand them. These include AI, edge computing, deep learning, and other powerful advances.

The world is awash in technology, some used for good and some for ill. Policymakers cannot ignore technology or conclude that it is too complicated to understand. This is why we hope Government Tech Insider will prove useful and lift the veil that oftentimes obscures certain technologies and the transformative impact they have on our everyday lives.

TOPIC 1 — A VIRTUAL WORLD WHERE HUMANS CAN THRIVE (THE METAVERSE)



It's the future we are working towards. A virtual environment where you can be present with people in a digital space. An embodied Internet that you are inside of.

— Mark Zuckerberg,
Meta CEO

What is it, really?

The metaverse is a planned virtual world filled with digital replicas of people, objects, and places. This idea evolved from video games. But Facebook made the concept mainstream when it changed its corporate name to Meta. In this hypothetical world, people can buy, trade, sell, and share things and experiences across an interoperable network of platforms. This alternate world — using technologies such as cloud, blockchain, and edge computing — seeks to create a boundaryless “third place.”

Where is it used?

The goal is to create a cross-platform virtual world, but for

now, the building blocks of the metaverse are generally isolated. Using Meta’s Oculus headsets, people can meet up in virtual rooms to collaborate, learn, and play games. Microsoft is already building its stack of applications for what might soon be known as the enterprise metaverse, with a focus on Azure Digital Twins and Microsoft Mesh, a mixed reality environment for project collaboration. Some governments are already exploring ways in which the metaverse can serve their citizens more effectively. In Seoul, South Korea, residents can use VR goggles to visit a virtual city hall to do everything from touring a historic site to filing a civil complaint.

Why it matters

The metaverse will upend how we think about and use valuables. Digital goods will become pervasive, and finance will become more decentralised through the use of digital currencies. Immersion in digital experiences will lead to a new way of interacting with both private and public sectors. Governments that are able to harness the drive towards digital everything will be better placed to offer value to their citizens.

What comes after COVID-19

The pandemic has changed the way people work and how



they perceive their workplace. Seventy percent of LinkedIn users say they want flexibility to work anywhere, but that same percentage also wants human connection. The metaverse can resolve this paradox through its focus on new experiences and the creation of a virtual space — one where people interact on a more personal level than they do on the traditional internet. With full immersion and two-way interaction, work becomes more engaging and productivity should increase in industries such as retail, urban planning, and healthcare.

Why it's happening now

The virtual world has come to life with the help of enormous amounts of cloud computing power as well as faster processors

that run small personal devices. Advances in 3D engines, sensors, headset technology, and internet speeds have made this possible. Successful games like Fortnite and Roblox have created vast audiences that make financial transactions, develop friendships, and even attend concerts virtually. Identities and economies are fluid and increasingly built on computer code.

Why governments should care

Bloomberg Intelligence predicts that the metaverse imagined by Facebook and Microsoft will be worth \$800 billion by 2024. Great wealth will be generated in this new economy and remain online. Governments will need to understand and manage

intellectual property rights for digital assets such as virtual land bought and sold across borders. Legal systems will need to adjudicate disputes that happen in no single physical location.

Challenges to adoption

The cost of metaverse devices, such as headsets and smart glasses, will stagger adoption with only a small percentage of the world able to afford it initially. Even those that can afford these devices will only use them if they become more streamlined and easier to use — much of the gear is still complicated and clunky. And for vulnerable individuals currently struggling to use social media, the metaverse could be trickier to adopt than expected.

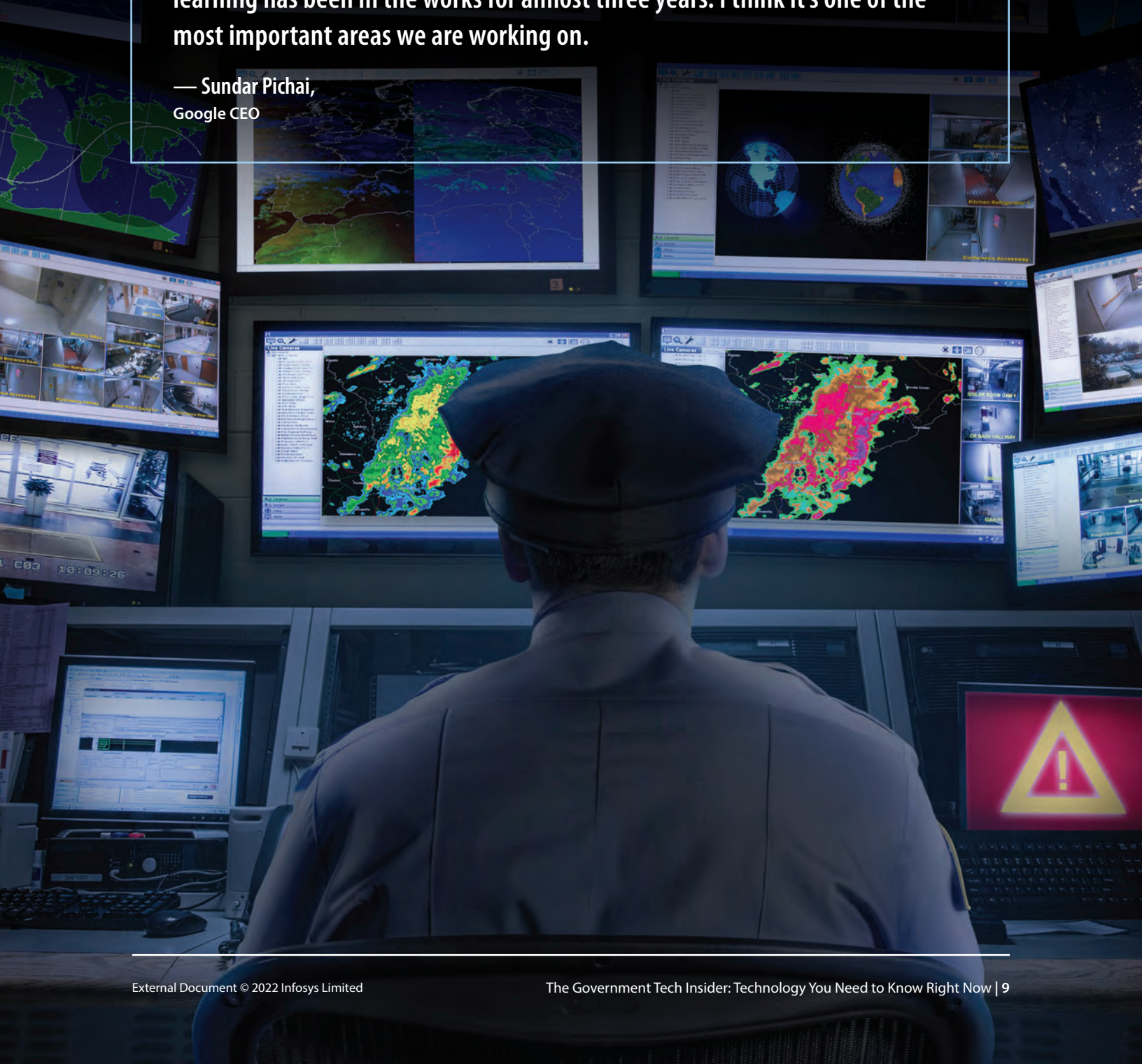


TOPIC 2 — SHARING INFORMATION WITHOUT SHARING DATA (FEDERATED LEARNING)



On user privacy and control, it's always been a big focus for us. Federated learning has been in the works for almost three years. I think it's one of the most important areas we are working on.

— Sundar Pichai,
Google CEO



What is it, really?

Federated learning allows mobile phones, tablets, and other devices to get smarter by training with data and AI models scattered around the world. Think of it as a well-rounded education for computer algorithms but without the need for a centralised classroom (your devices' servers).

Where is it used?

This technology helps make smartphones seem so smart with sentence completion, voice recognition, and facial recognition to replace passwords. Autonomous vehicle navigation systems also rely on this technology. Increasingly, the aerospace industry uses federated learning to share aircraft data and help airlines predict potential system failures.

Why it matters

This aspect of AI is great when wireless signals are unreliable but users still need their devices to work — right now. Also, federated learning shares the models for analysing the data but not the actual data, so there is less risk that sensitive information will be exposed to cybercriminals. The handling of data is particularly important when complying with the General Data Protection Regulation (GDPR).

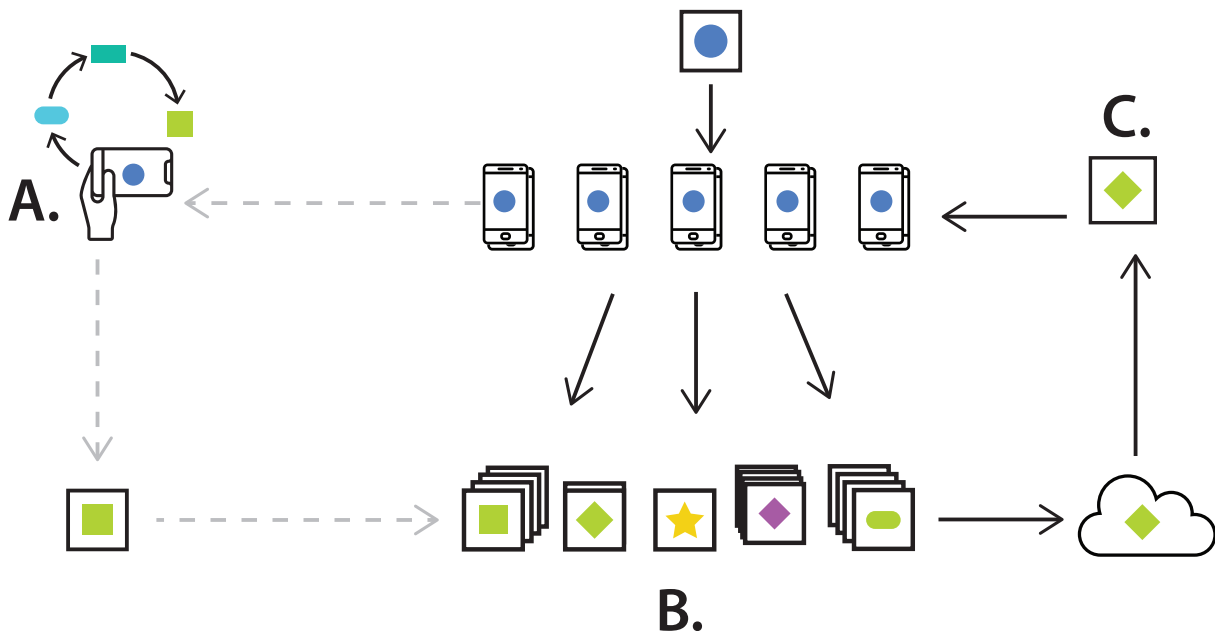
What comes after COVID-19

Federated learning will help governments around the world tackle potentially catastrophic threats. Critical data needed to manage crises

are often housed in silos and cannot be transferred among agencies or across borders. With billions of devices using these new machine learning techniques, federated learning will accelerate developments in healthcare, transportation, and other critical areas.

Why it's happening now

Federated learning is gaining popularity for the same reasons that smartphones are now more powerful than supercomputers of the past. Specialised computer chips pack more horsepower into smaller packages, while smarter software maximises that potential.



Source: Towards Data Science. 2020. [Introduction to Federated Learning and Challenges](#)

Why governments should care

Federated learning stands to have an enormous impact on how governments deliver public services. Smart cities will use federated learning to tackle common challenges, such as traffic optimisation, fee and toll management, and sustainability, while conversational chatbots will direct citizens to the right departments and services.

Federated learning is already being used to “train” medical products on data worldwide without sensitive patient information crossing borders. Existing medical data is not fully exploited by machine learning, primarily because it sits in data silos with access restricted due to privacy concerns. However,

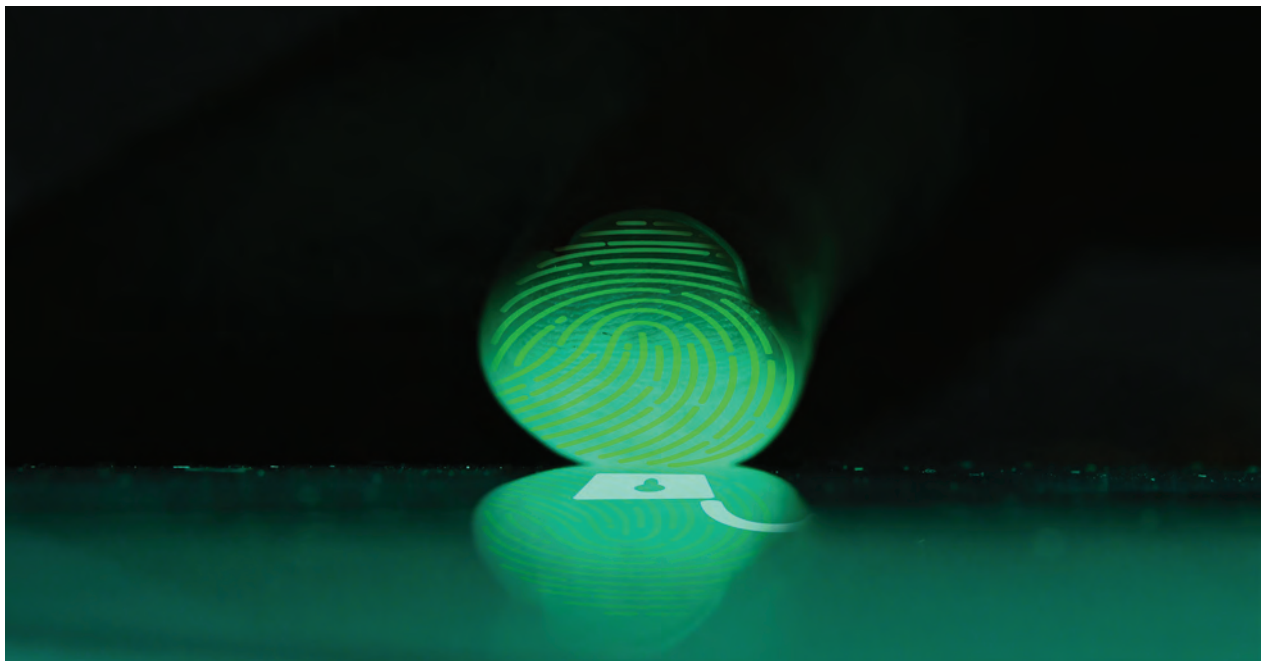
federated learning offers a solution to this challenge, and it will enable continued innovation in areas such as radiology, pathology, and genomics without moving patient data beyond the firewalls of the silos in which they reside.

Challenges to adoption

Federated networks are composed of a massive number of devices, and communication in the network can be slower and more expensive than that in classical data centre environments. It is therefore necessary to develop efficient communication methods that iteratively send small messages or model updates as part of the training process as opposed to sending the entire dataset over the network.

Privacy is often a major concern in federated learning applications compared with learning in data centres. Federated learning takes a step towards protecting user data by sharing model updates instead of the raw data. However, communicating models, which update throughout the training process, can nonetheless reveal sensitive information, either to a third party or to the central server.

In use cases like smart cities, there are significant real-world problems in getting them off the ground. Toronto, for example, shut down Alphabet’s Sidewalk Labs project in 2020 when residents objected to the company’s approach to privacy and intellectual property. And even when it works, there’s the challenge of getting different local authorities on-board to do joined-up implementations and make federated learning work.



TOPIC 3 — UNDERSTANDING VIDEOS THROUGH AI (VIDEO-BASED DEEP LEARNING)



It's going to be interesting to see how society deals with artificial intelligence, but it will definitely be cool.

— Colin Angle,
Co-founder of iRobot

What is it, really?

Computers can easily sort through vast collections of words or numbers but struggle to make sense of streaming video. Deep neural networks and new open-source AI models now make it possible to solve video-based problems, which have traditionally been human-only tasks. Deep learning technology analyses live video and can quickly identify anomalies or interesting events. This transforms raw video into structured data that can be further analysed, much like words or numbers.

Where is it used?

This technology can help moderate content and create video captions and highlights. Organisers of the Wimbledon tennis championship used computer vision models to identify the most compelling moments in matches. AI is also used by governments for surveillance and by businesses for security and infrastructure monitoring.

Why it matters

Streaming video can now be analysed in nearly real time, processing vast amounts of data that would otherwise be missed. Advances in machine learning techniques also make this technology accessible to

those who aren't AI experts. Video analytics is projected to be a \$4.23 billion industry.

What comes after COVID-19

The technology can help retailers better understand how customers use and interact with physical stores, which are expected to change in a post-COVID-19 world. Also, this technology can automatically monitor social distancing in public places, a benefit now and also when planning for future crises.

Why it's happening now

Image classification error rates have fallen from more than 25% to less than 2% in the past decade. The classification can now be accomplished efficiently with pretrained models that eliminate much of the data labelling and preparation work.

Why governments should care

AI can automate and simplify media management for policymakers. For healthcare providers, video streams of operations can be indexed for research. Big tech can also use this technology to flag inappropriate content and attempt to minimise hate speech on social media. As the latest development in surveillance,

AI can "watch" surveillance video and potentially identify suspicious behaviour, making AI an important law and order development.

Challenges to adoption

High-resolution images are needed for some important uses, such as surveillance. That can be a problem for most video analytics software. And with so many parameters, the analysis can require the use of cloud computing. That sometimes creates a communication bottleneck when insights are needed in real time.

Clearly surveillance technologies raise significant privacy and ethical concerns, and video surveillance has yet to be proven as accurate or effective. Additionally, there are geopolitical considerations given the technologies is being developed and utilised by authoritarian governments. Any engagement in this technology should consider the inherent humanitarian concerns, and reputational issues that could result from its use.

TOPIC 4 — MAKING LIFE MORE INTERACTIVE WITH AI DESIGN (HYPERPERSONALISATION)



The best way to predict the future is to invent it.

— Alan Kay,
Computing pioneer



What is it, really?

Hyperpersonalisation is when every experience and decision is customised through the use of AI and real-time data. The user is offered tailored, relevant content, dynamic screens, and interactive interfaces. Basically, users have their own unique experiences, depending on how they use a system.

Where is it used?

This approach is often used by retailers to target smaller and smaller groups and to predict what they might want. The live enterprise initiative at Infosys also applied hyperpersonalisation to its internal InfyMe app and its Launchpad onboarding app. The apps react differently based on the individual's job level, responsibilities, and needs.

Why it matters

This technology puts the individual — whether employee or consumer — at the centre of each experience. That makes happier customers and more productive and engaged employees in the private and public sectors. Hyperpersonalisation can also democratise analytics and lead to more knowledge sharing in an organisation.

What comes after COVID-19

The pandemic has changed the way people work, shop, and spend their leisure time. Rather than guessing what people need based on outdated assumptions, hyperpersonalisation can steer organisations in the right direction. This is also particularly beneficial for retailers and healthcare professionals who need to react to customer and patient data in real time.

Why it's happening now

Faster computer models and higher communication speeds mean that edge devices — such as mobile phones — are no longer bottlenecks. And with computational design moving into the mainstream, interactive user interfaces are now possible.

Why governments should care

Hyperpersonalisation allows the public sector to provide bespoke customer service. Real-time behavioural data allows these organisations to react to resident queries and to tailor the experience appropriately. Although councils hold a wealth of resident data, they often lack the tools to provide a personalised customer

experience. AI and intelligent automation can revolutionise the way local authorities use data across all interfaces and channels.

Utility companies are already harnessing this technology. Phone numbers identify the residents who are contacting them as well as their locations. If there is a nearby outage, callers are automatically directed to an interactive voice response recording, which provides them with instant access to information about the situation. The enquiry is answered automatically — freeing up human staff to address more complex customer queries.

Challenges to adoption

Hyperpersonalisation requires advanced AI algorithms and a digital brain — an organisation's blueprint. Those can be costly and difficult. The use of cloud computing architecture also needs to take into account regulatory issues, such as the GDPR.

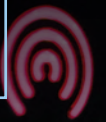
More importantly, the public often distrusts and opposes this kind of technology, given the lack of visibility into the data sharing and sales going on behind the scenes. Further challenges include rolling this out at scale, especially to marginalized communities where many rely on outdated tech that is no longer supported.

TOPIC 5 — SECURING INFORMATION IN THE CLOUD (CLOUD DATA SECURITY)



It takes 20 years to build a reputation and a few minutes of cyber incident to ruin it.

— Stephane Nappo,
Cloud security practitioner



What is it, really?

Organisations sprinted to the cloud to make sure operations didn't falter as offices emptied. To ensure they can continue to communicate and innovate, companies are increasingly using born-in-the-cloud applications, from Microsoft Teams and Slack for massive enterprise resource planning solutions. Previously, many companies were suspicious of cloud computing and storage, assuming it was less secure than having data on the premises. But that perception has changed.

Where is it used?

Security is baked into the code used to deploy cloud solutions. Without this, multibillion-dollar services such as Amazon Prime, Disney+, Dropbox, and Google Drive wouldn't work. The use of secure-by-design principles — in which security is considered throughout the engineering

process rather than at the end — has eliminated many concerns about working in the cloud.

Why it matters

Cloud has become the de facto standard for deploying company IT systems. The cloud provides businesses and governments with the ability to adjust workloads as needed and to make it easier to add new features. Working in the cloud also ensures that security patches are immediately installed, avoiding a common failure in traditional systems.

What comes after COVID-19

Businesses of all sizes have moved more of their operations to the cloud and are still learning to fully use the technology in new ways. From e-commerce to supply chain planning to working capital management,

critical elements of the economy are shifting to the cloud. The innovation the technology facilitates is likely to transform economies in unpredictable ways.

Why it's happening now

Security controls on legacy systems are often not up to scratch. In 2020, public cloud infrastructure from the likes of Google and AWS were [predicted to suffer at least 60% fewer data security incidents](#) than those in traditional data centres. As cloud grows in relevance, businesses are forced to adopt it to keep up with the competition.

Why governments should care

Cloud computing has not only become ubiquitous among private businesses but across



the public sector too. Local and central governments, police forces, and others now harness networks of remote servers to provide vital services, communicate with each other, manage data, and keep IT costs within budget. Whether it's a council taking payments from residents or a police force sharing crime data with another, the U.K. public sector is fully cloud conversant.

Given that government departments handle large swathes of private data, this makes cloud security all the more important. Previous public sector security breaches, such as the 2017 WannaCry attack on the National Health Service, have shown the vulnerability of public-

sector defences. It is important that policymakers continue to monitor the defences put in place to safeguard public-sector systems and ensure they meet the cloud security standards set by the National Cyber Security Centre.

Challenges to adoption

Transformation to modern cloud security systems is vital but can be expensive. There are also thousands of cloud products, making it difficult for companies or governments to choose the right one or even to decide

on the right strategy. Cloud providers all operate under the shared responsibility model. They differ in their offerings, each with unique strengths and weaknesses. Firms in both the public and private sector will have to make the trade-off between big cloud providers that are secure and reliable, but expensive, and cheaper boutique providers that are more bespoke but have less reliable track records on security. To navigate these challenges, organisations need to understand these dynamics.

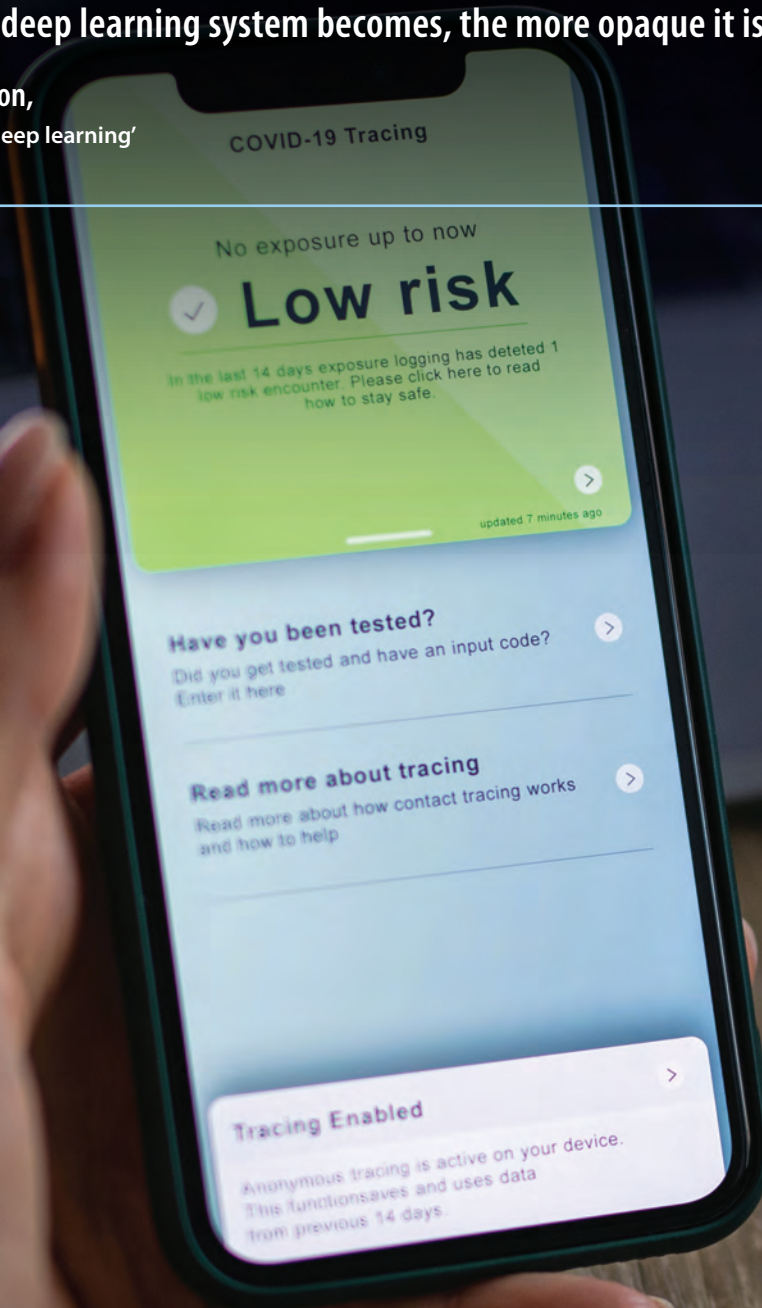


TOPIC 6 — AVOIDING AI CONTROVERSIES (AI GOVERNANCE)



A deep learning system doesn't have any explanatory power. The more powerful the deep learning system becomes, the more opaque it is.

— Geoffrey Hinton,
The 'godfather of deep learning'



What is it, really?

The goal of AI governance is to explain how and why the technology makes certain difficult decisions. Why was one person not given a mortgage? What should autonomous vehicles do when faced with the possibility of a fatal wreck? With ever more powerful deep learning algorithms, the difficulty of explaining decisions has only become harder.

Where is it used?

AI-based systems are now making decisions on their own. Some courts use deep learning to sentence criminals. Banks rely on the technology to grant loans. Some AI can even detect cancer autonomously. That has led to a greater embrace of explainable AI (XAI) as a way to insert more transparency into such important decisions.

Why it matters

Biased or unfair decisions can have serious consequences for a company's reputation and people's lives. For instance, in 2020, visual database ImageNet announced it would remove more than half a million images after finding racial bias in its labelling. In healthcare, some AI systems have performed much better on trial data than on real-world data, leading to backlash from authorities. In one

instance, an AI model "cheated" on predicting pneumonia by first rating the quality of the X-ray machine.

What comes after COVID-19

A growing number of algorithms are making important decisions that affect people's lives. Some of the more serious AI failings have been discriminatory decisions that hurt marginalised groups and low-income citizens. Those groups are already suffering disproportionately from the pandemic.

Why it's happening now

As ever more powerful deep learning AI algorithms are implemented, the difficulty of explaining their decisions has become harder. High-profile AI failures have attracted the attention of companies, governments, and the public. AI ethics and governance were cited in thousands of research papers in 2020.

Why governments should care

In its policy paper on the AI Sector Deal, the U.K. government predicted that the development of this technology could have the same dramatic impact on society as did the invention of the printing press. The anticipation of a new AI era and increased deployment of algorithmic

decision systems has been accompanied by wariness about how such technology will be used and regulated. In late 2018, the U.K. launched the AI-focused Centre for Data Ethics and Innovation, which is responsible for advising the government about how to maximise the benefits of these technologies as well as for helping them build a strong, trustworthy system of governance.

Challenges to adoption

The Department for Education faced significant criticism in 2020 about the algorithm used to grade A-level results, whilst a Home Office algorithm designed to determine the outcome of visa applications was abandoned after accusations of racial bias in the decision-making process. In 2019, the government charged the Centre for Data Ethics and Innovation with scrutinising algorithms used in the justice system and across financial services. However, as innovations such as predictive policing continue to be adopted across both the public and private sectors, they will accompany a growing need for transparency. The public and other stakeholders demand to know why certain algorithms and AI systems are adopted, how they make their decisions, and whether biases in their programming result in discriminatory decision-making.

TOPIC 7 — DEMOCRATISING DATA ANALYSIS (DATA MARKETPLACES)



Information is the oil of the 21st century, and analytics is the combustion engine.

— Peter Sondergaard,
Senior vice-president at Gartner Research

What is it, really?

Datasets and models now can be shared among enterprises (and governments) in pooled databases. With information available to everyone, data marketplaces are dynamic and also democratise this important resource. The technology also makes data, analytics, and AI models accessible to non-specialists.

Where is it used?

A data marketplace is often set up by leading firms both within and across industries. Equinix is an example of an AI data marketplace in the U.S. that provides a rich ecosystem of data service providers and vendors. The U.S. government uses that marketplace to develop predictive models for natural disaster emergency scenarios and for better predictive maintenance of military aircraft.

Why it matters

Data monetisation and knowledge sharing correlate with stronger business performance, according to McKinsey research. With better data and models at the fingertips of every person in the company, firms can quickly add new services or entirely new business models.

What comes after COVID-19

The ability to pivot quickly to manage disruptions — such as those in supply chains — is more pressing now. Firms and

governments that are data-driven are better able to adapt and remain agile in these areas.

Why it's happening now

Data has become more important in the decision-making process, no matter whether decisions are made by executives or AI. Seventy percent of business executives have reported that data and analytics have changed the nature of their businesses in the past three years. These new marketplaces will be increasingly important sources of data for companies and governments.

Why governments should care

Data is vital infrastructure at city, national, and global levels. Stable, reliable, and well-maintained data infrastructure helps us make better decisions, brings new services, and supports innovation. In 2016, Copenhagen launched its City Data Exchange to create a marketplace for public and private data providers and to allow that to be monetised. The Greater London Authority is now following suit by building upon the existing London Datastore.

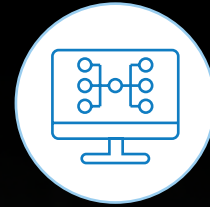
Sadiq Khan, the mayor of London, has said that by “responsibly opening up a huge amount of data held by our public sector partners and working with

London’s brilliant tech sector, we’re helping tackle some of the most urgent challenges facing our city as it grows. The next step is to create a shared approach for the city so we can all benefit from the innovation this will bring — while using the data we hold on Londoners’ behalf transparently, safely, and securely.”

Challenges to adoption

Some hurdles include convincing organisations to pool data, agreeing on pricing, and affording often expensive datasets. There is also a concern that data-driven decisions often result in the elimination of jobs. However, management can use those insights to augment jobs by reducing repetitive and non-creative labour.

TOPIC 8 — DESIGNING PRODUCTS FOR DIVERSE POPULATIONS (SYSTEMS THINKING)



When you are trying to do something different, there is risk not just in the process but in the market, in the brand, and in the product you're trying to launch.

– Mauro Porcini,
Chief design officer at PepsiCo



What is it, really?

Systems thinking, which includes systems design, is a top-down view of user journeys and data flows. This approach seeks out all the interconnected elements of a system to find solutions. This can be used to create products and services for continuously changing cultures. The paradigm allows organisations to weave environmental, social, and governance principles into business decisions.

Where is it used?

This is a new field, but adoption is growing. At WONGDOODY,

an Infosys company, executives used systems thinking to build a platform that educates underprivileged children in developing countries. This approach was also utilised at Nestlé’s U.S. evaporated milk factory to eliminate the need for 63 million gallons of water annually. That was a particularly important benefit when the region was facing a drought.

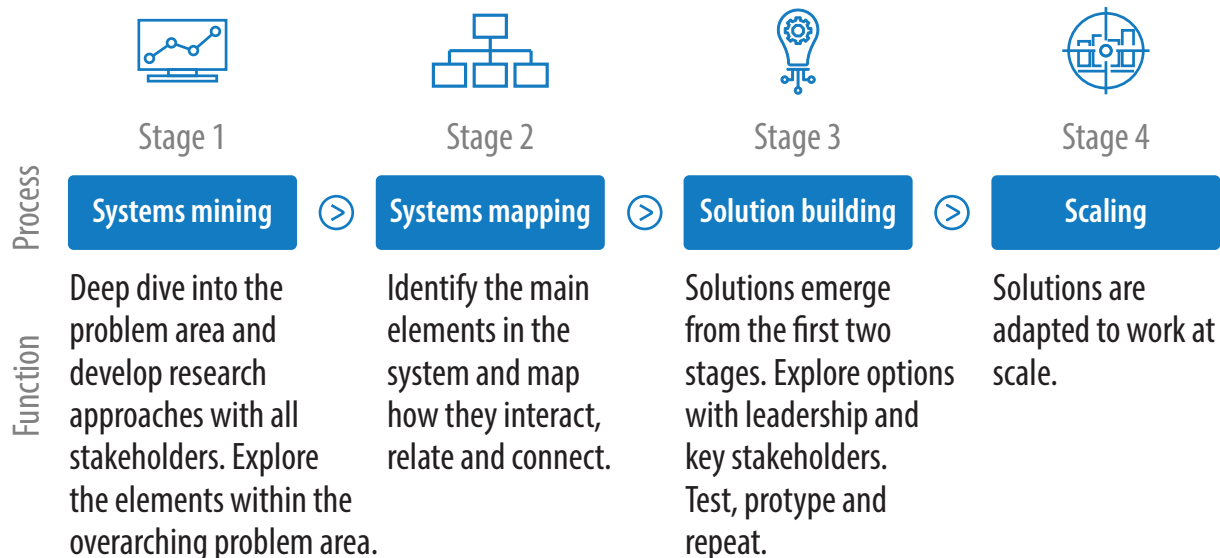
Why it matters

The solution is both bottom up and top down. It uses a customer and systems perspective, which provides stronger guidance about how solutions will work

at a large scale. Additionally, those solutions are much more likely to appeal to a wider group of stakeholders, ensuring compliance and ethical ways of working.

What comes after COVID-19

Equality issues exposed by the pandemic are shining a brighter spotlight on ethics, good governance, and social responsibility. Systems thinking provides an opportunity to create a better status quo in the future rather than returning to the old one.



Source: Towards Data Science. 2020

Why it's happening now

Systems design built upon previous approaches was helped along by technological advances. Along with a focus on empathy and collaboration, good systems designers need to have strong data science and modelling skills, which are in greater supply now.

Why governments should care

Good systems design can help ensure that projects meet regulatory standards and can

reach the market faster — a win for businesses and governments. Also, given the amount of data being produced, many world-changing government solutions must work with an ever more intricate network of different systems and stakeholders.

The adoption of systems thinking will enable governments to better implement public policy and serve their citizens. It will enable ministers and their officials to address more complex challenges, particularly where they cut across different departments. The U.K. Cabinet Office has recognised the value systems thinking can bring and has published a strategic framework, designed to put systems thinking into action. It is also supported by a dedicated, multidisciplinary systems unit,

whose role is to help apply the principles of the strategic framework across Whitehall.

Challenges to adoption

For the method to work, a systems thinking or systems design team must work with a diverse group of stakeholders throughout the project. Experts will have to be included at various points, which can be costly and time-consuming. Also, good system design talent must have a data science background, which is in high demand for other jobs.



TOPIC 9 — AVOIDING SUPPLY CHAIN SHOCKS (RESILIENT SUPPLY CHAIN PLANNING)



What gets measured gets improved.

— Peter Drucker,
Considered the father of modern management



What is it, really?

A resilient supply chain is one that can react quickly and efficiently to huge swings in supply and demand, as the world observed at the beginning of COVID-19. Many firms use off-the-shelf supply chain planning software and then fine-tune it to deal with cataclysmic events. In optimising this software, retailers and manufacturers use sophisticated models to predict patterns and accommodate massive amounts of data — from weather to consumer sentiment.

Where is it used?

Organisations around the world, including global retailers, manufacturers, and governments, are building resilient supply chains. They are stress-testing their vulnerability to disruptions in all directions. Advanced analytics and machine learning help firms predict supply shortages, adjust pricing strategies, and piggyback on existing networks when their supply chains fail.

Why it matters

This cognitive and resilient supply chain ethos is being used to administer the COVID-19 vaccine to the world's population,

especially in poor and rural areas. These smarter systems can also make supply chains more equitable by providing better access to low-income and marginalised groups.

What comes after COVID-19

More resilient supply chains will enable governments to administer health care more effectively and ensure that smaller businesses have access to the goods and services they need. Many companies will also take the opportunity to make their supply chains more compact and less vulnerable to global events.

Why it's happening now

The pandemic exposed the fragility of supply chains, many of which were originally assembled with cost and efficiency in mind. Now organisations worldwide understand how easily threats can disrupt those networks. Further, global tensions between China and the United States have forced some companies to rethink their supply chain strategies.

Why governments should care

Vaccines to combat COVID-19 were developed in record time. With that barrier having fallen, drug-makers and governments

worldwide had a logistics problem. How do they get billions of doses of the vaccines to the people who need them? The need for a smarter and more resilient supply chain continues to be important for the distribution of vaccine booster doses and test kits.

Challenges to adoption

Supply chains are already well established, and consumers have grown accustomed to those networks' ability to provide cheap goods. To be effective, the next generation of supply chains must be able to share data among a wide variety of partners. Also, the use of big data and AI in this field has yet to mature, which leaves some supply chain planners to work out some of the finer details.



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